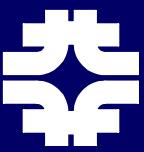


# ILC Cryogenics

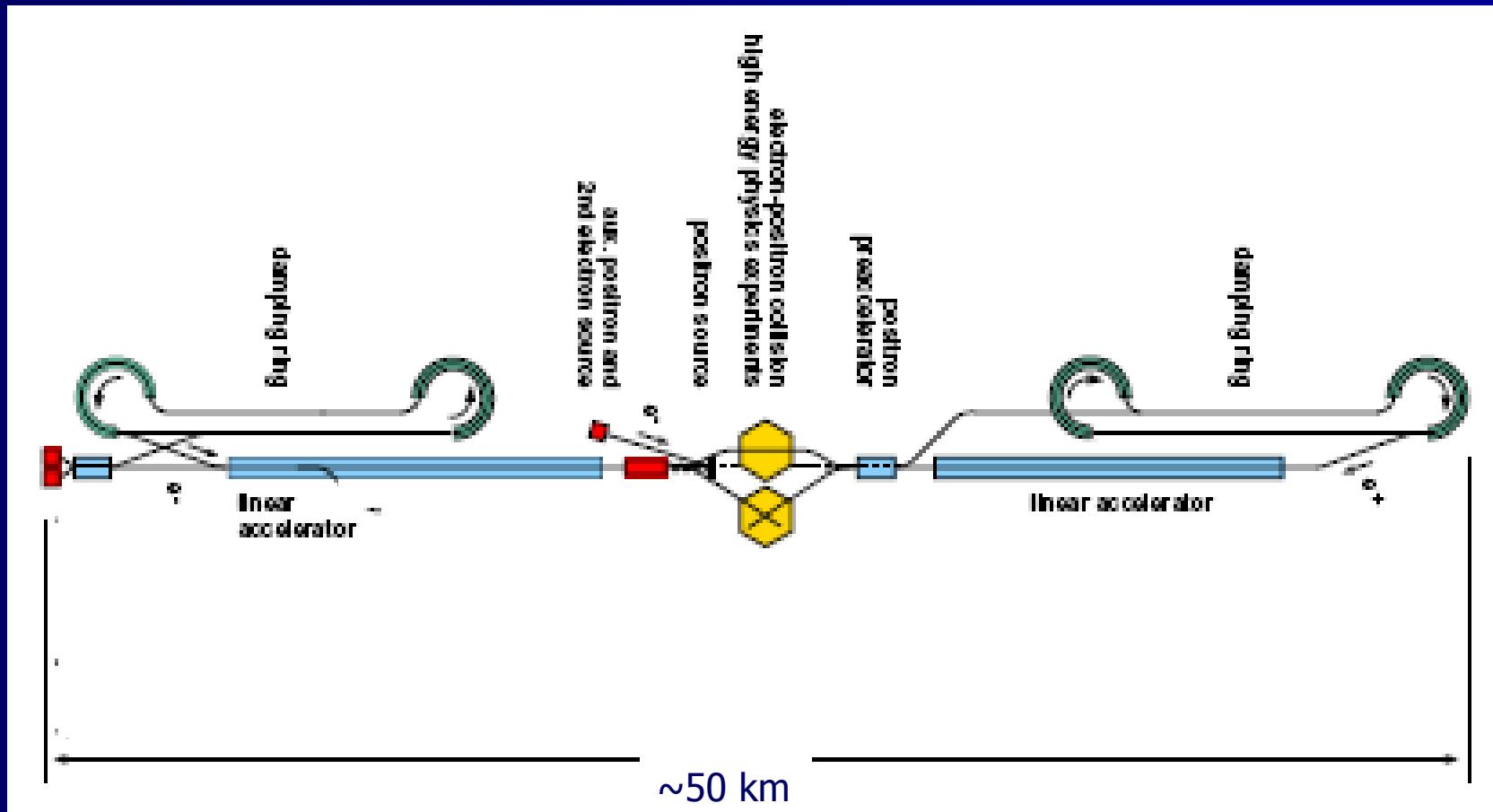
Jay Theilacker

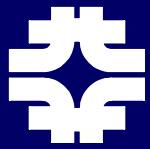
# Cryogenic Working Group

- Overview of cryogenics for the ILC  
(Based largely on TESLA design)
  
- Presentation of cryogenic constraints and issues to foster an open discussion

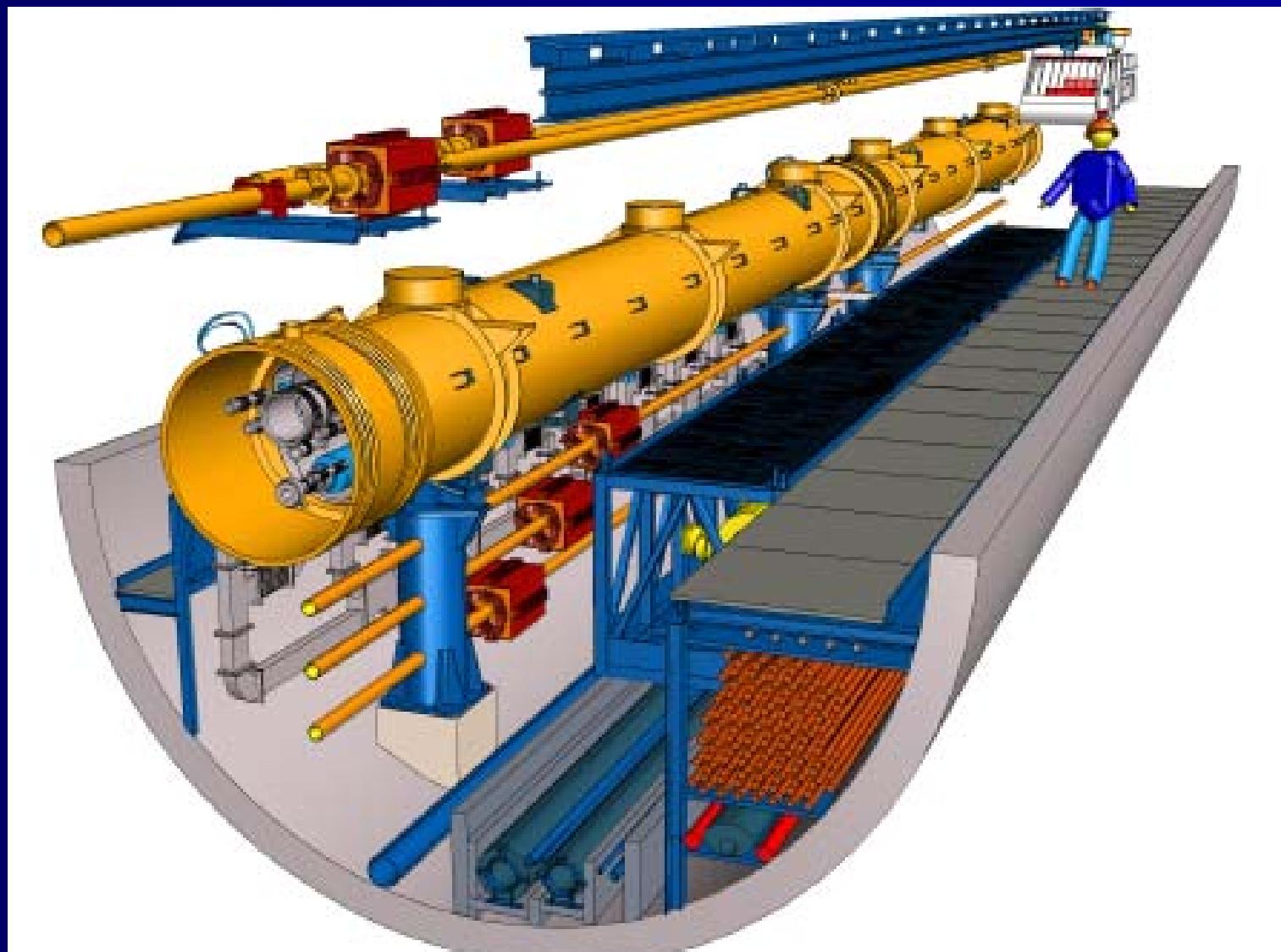


# Possible ILC Configuration



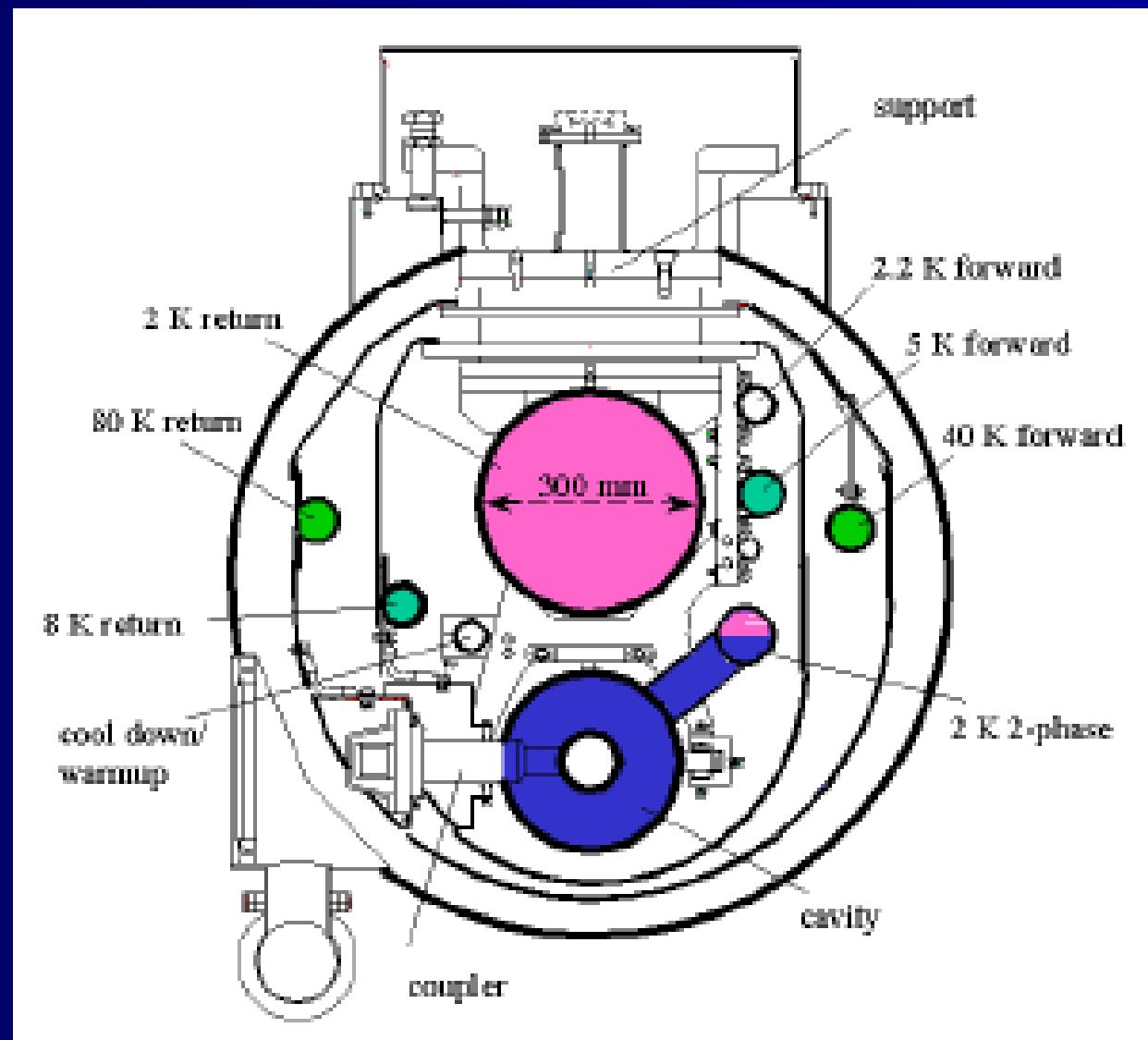


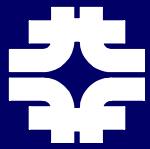
# Single Tunnel Cross Section





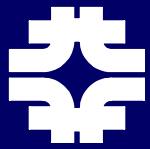
# Cryomodule Cross Section





# Basics of the ILC Cryogenics

- Saturated He II cooled cavities @ 2K
- Helium gas thermal shield @ 5 -8 K
- Helium gas thermal shield @ 40 -80 K
- Two-phase lines, supply and return, are connect to each helium vessel
- Two-phase line connects to gas return at each module
- Warm-up/Cool-down line connects the bottoms of the each helium vessel
- Subcooled helium connects to two-phase line via JT valve every ten (10) modules



# Terminology

SC Linac [e<sup>+</sup>, e<sup>-</sup>]

Cryogenic Unit

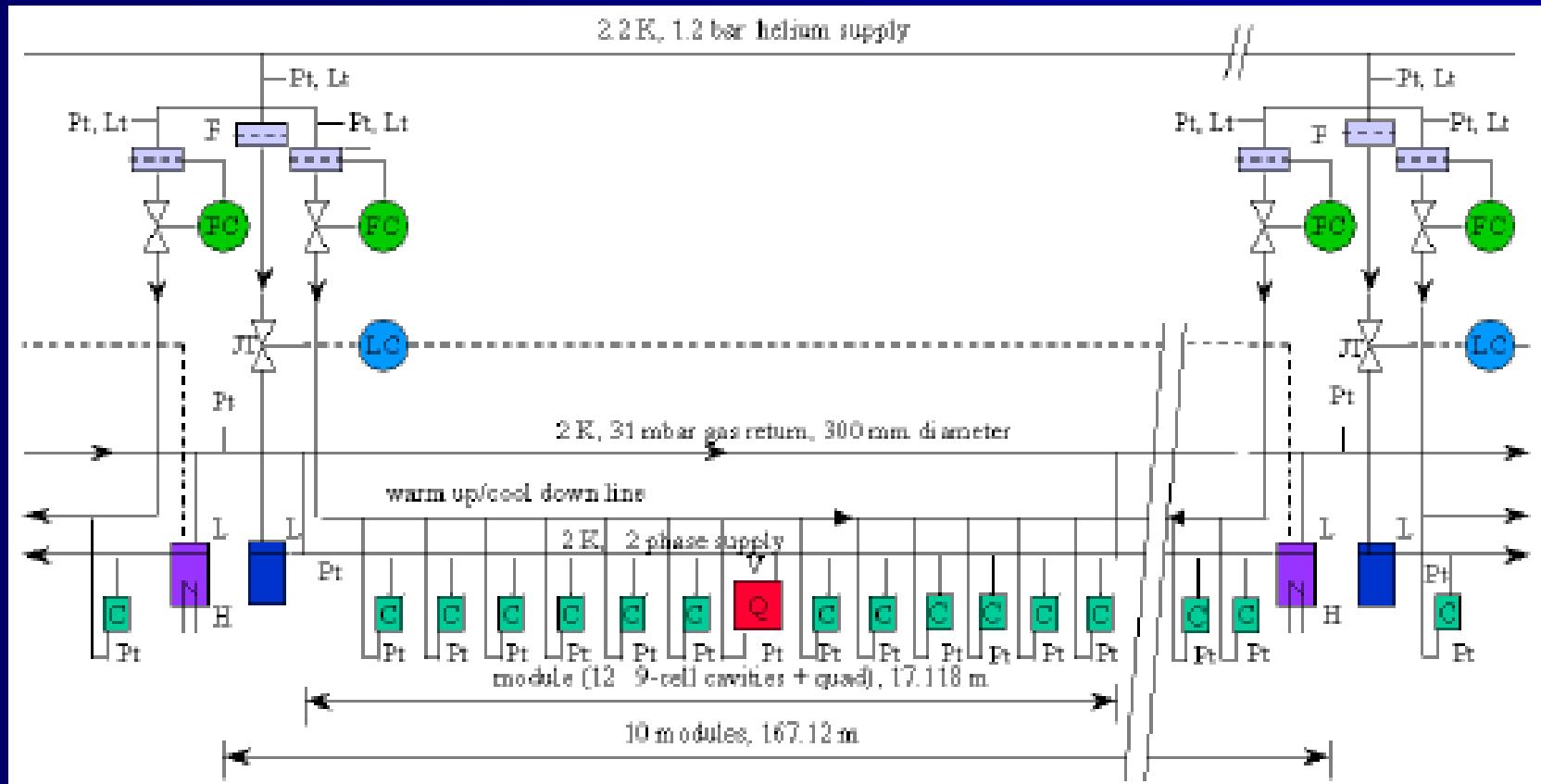
Cryogenic String

Cryomodule

Cryo Vessel

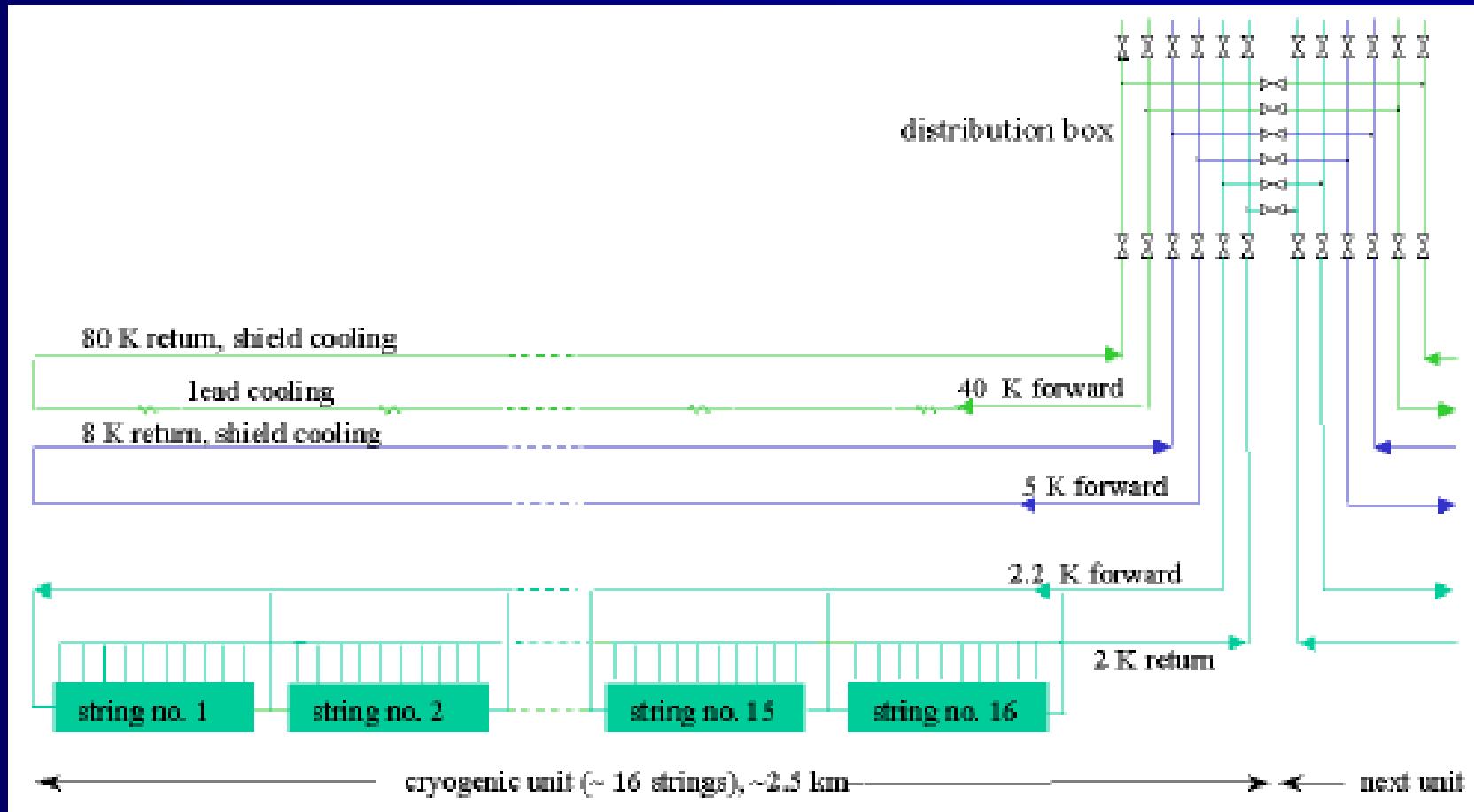
Cavity

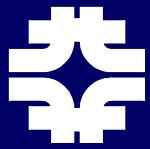
# Cryogenic String





# Cryogenic Unit



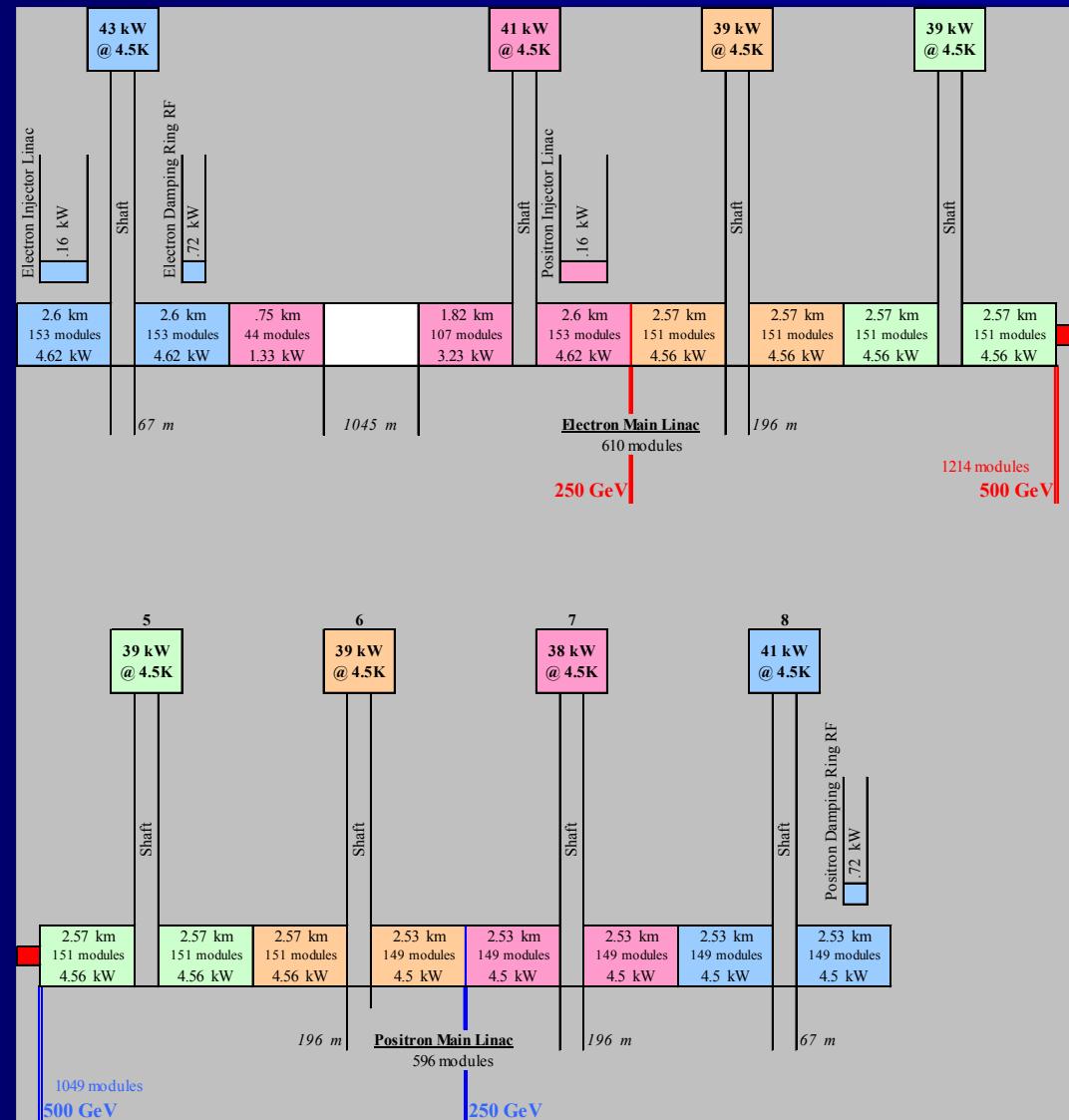


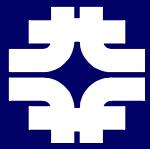
# Module Heat Load

		1 TeV					
		Dynamic					
Static		RF	HOM	Total	4.5K Eqv		%
	W	W	W	W	W	W	%
2K	1.74	26.24	2.21	30.19	68.50	62%	
5-8K	11.32	6.13	3.43	20.88	14.63	13%	
40-80K	90.13	306.17	28.50	424.80	27.16	25%	
					110.29	100%	



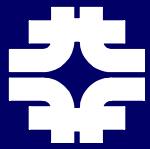
# Plant Configuration





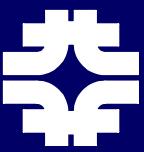
# Cryogenic Unit Heat Load

Linac Segment	Temperature K	Static Load kW	Dynamic Load	Total Load kW	Equivalent kW @ 4.5 K
<b>Cryounit 1</b>	2	0.27	4.35	4.62	10.48
153 Cryomodules	5-8	1.73	1.46	3.19	2.24
	40-80	13.79	51.20	64.99	4.16

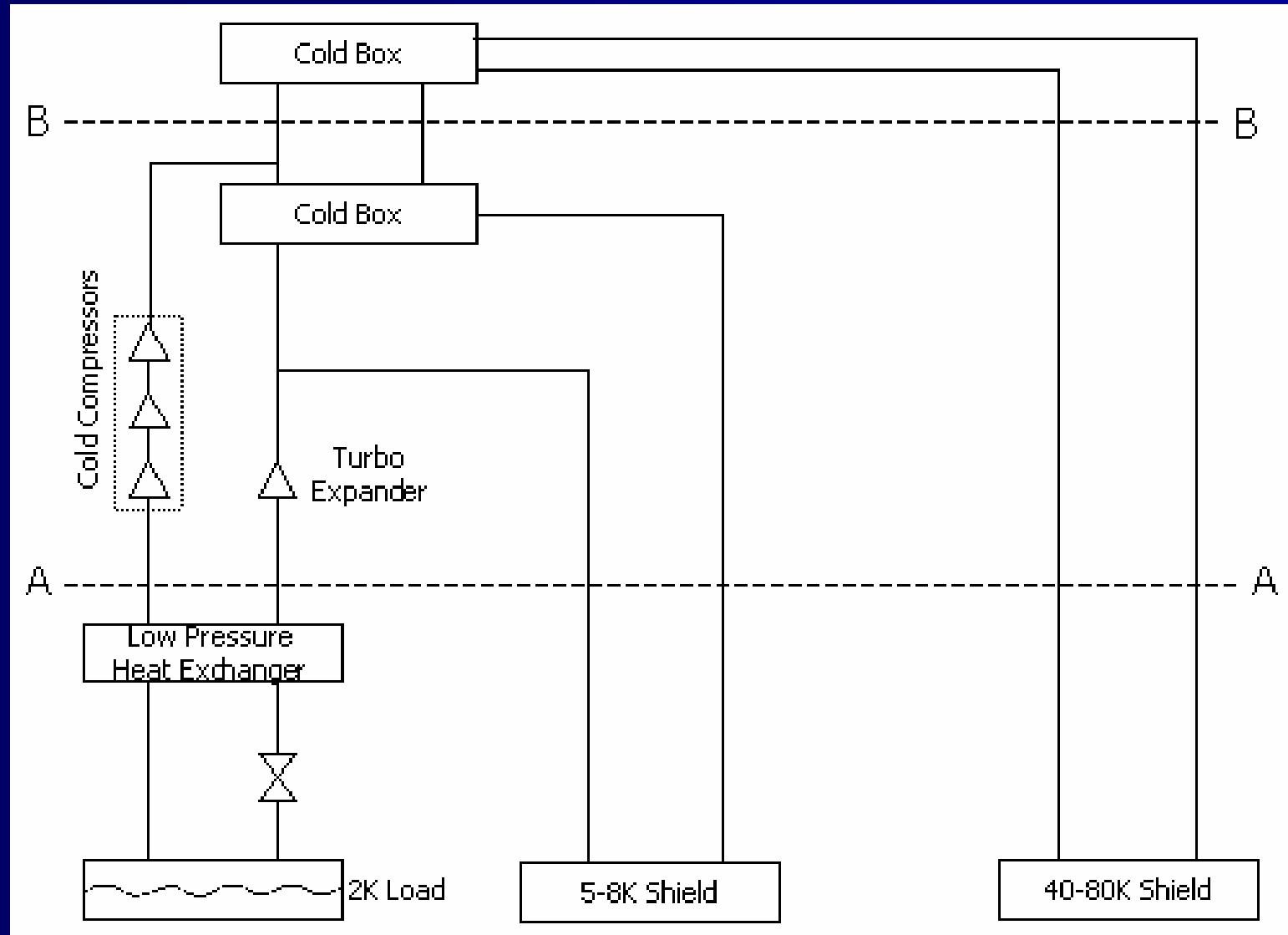


# Cryogenic Plant Capacity

Plant #	Nominal kW @ 4.5K	Design kW @ 4.5K	Wall Power MW
1	37.0	43.3	13.4
2	34.6	40.5	12.6
3	33.3	39.0	12.1
4	33.3	39.0	12.1
5	33.3	39.0	12.1
6	33.1	38.7	12.0
7	32.9	38.4	11.9
8	35.0	40.9	12.7

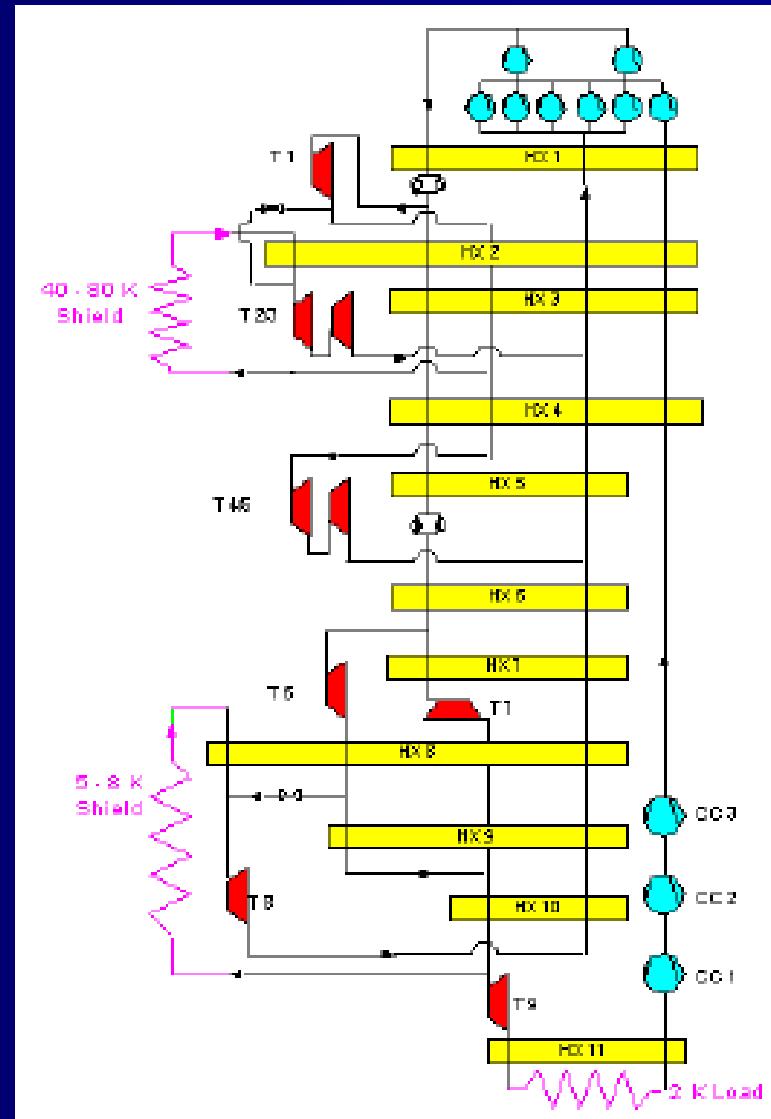


# Cryogenic Block Diagram

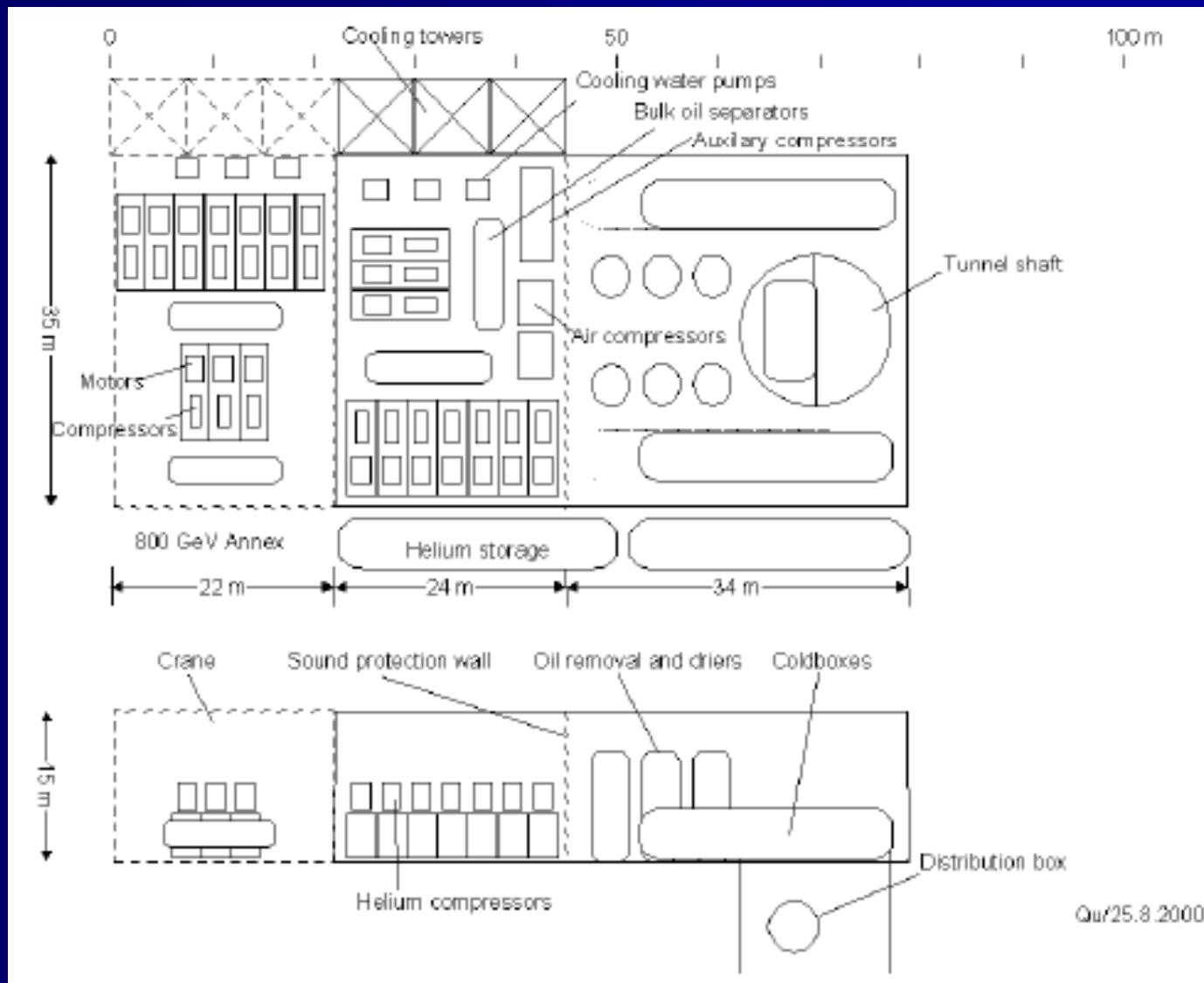




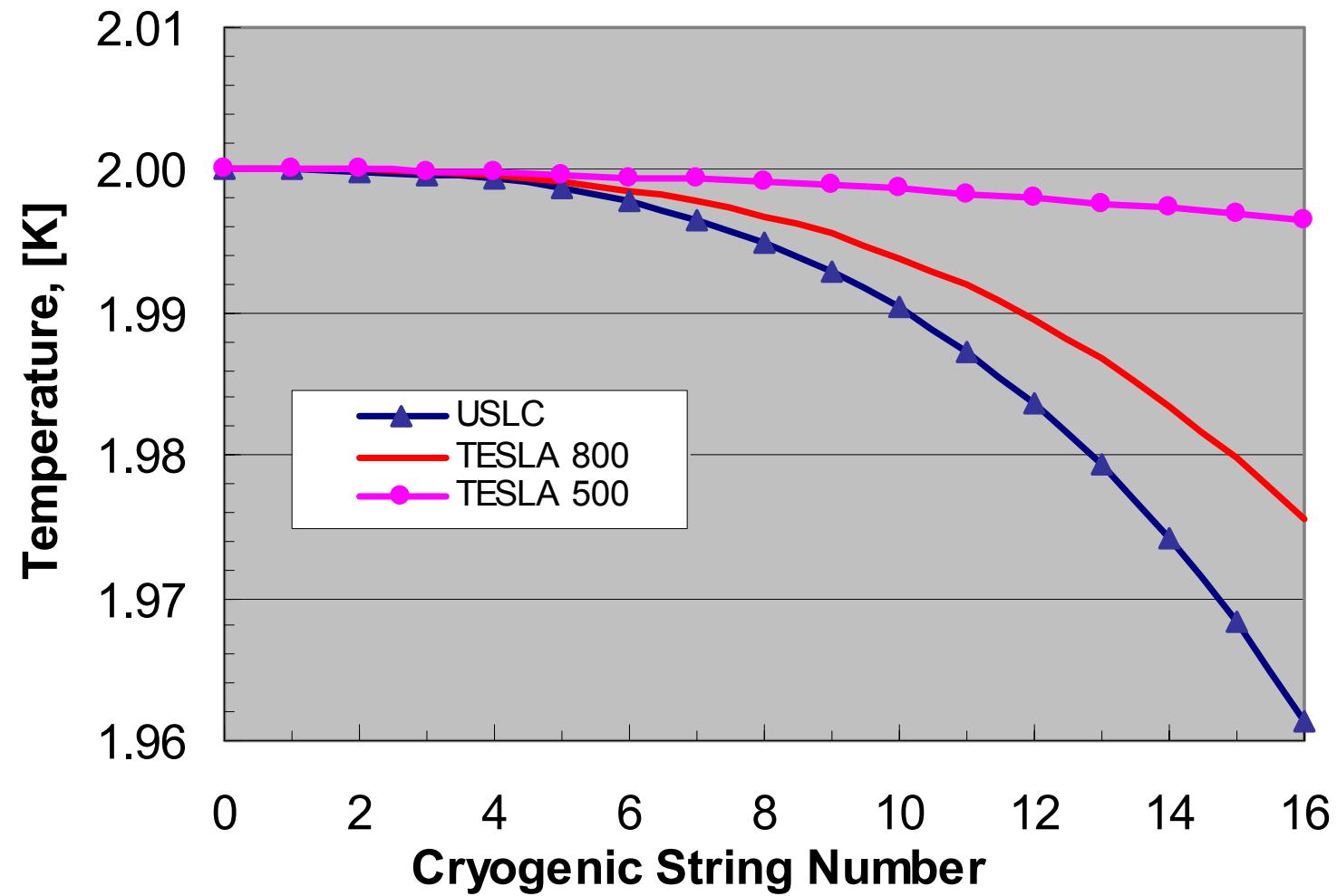
# Model Cryogenic Plant

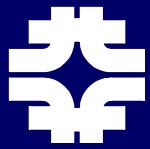


# Plant Service Building Layout



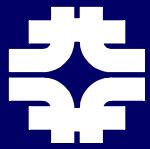
# Cryogenic Unit Pressure Drop





# Cryogenic Issues

- Maximum single plant size
- Cryogenic cycle
- Multiple plant relative size (turndown, efficiency, and availability)
- Split plant option due to elevation
- Laser straight vs. following Earth curvature
- System optimized temperature profile of Cryogenic Unit
- Sector size for warm-up and repairs



# More Cryogenic Issues

- Inventory management
- Thermal cycle impacts
- Instrumentation and control
- System MAWP
- ...